# SIGMA XI QUARTERLY

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## JACKSON ON "WHAT IS SCIENCE?"

## INFORMATION NUMBER

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# SIGMA XI QUARTERLY

VOL. XVIII SEPTEMBER, 1930 NO. 3

## WHAT IS SCIENCE?

C. M. JACKSON, PROFESSOR OF ANATOMY, UNIVERSITY OF MINNESOTA

*Presidental Address before the Minnesota Chapter of the Society of the Sigma Xi, May 26, 1930*

A year ago, on a corresponding occasion, Professor J. Arthur Harris gave a memorable address before this Society on the subject of "Frontiers." In the meantime, he has passed beyond the great frontier of life, and we are left to mourn the edparture of our beloved "companion in zealous research." We have suffered the irreparable loss of his leadership, but his memory will always be a source of inspiration.

Following his example, though conscious of my inability, I have ventured likewise to discuss some of the broader aspects of science. The inevitable specialization in our scientific work, and particularly in scientific research, tends unfortunately to narrow our vision and ultimately to obstruct progress. A broader outlook is needed to appreciate the significance of the various small corners in which we work. And especially for Sigma Xi, the nature of science is a theme demanding our attention because of an important matter of fundamental policy which is now pending. The question is, what branches or fields of knowledge shall be considered as science, in which investigators may be recognized as eligible for membership in our organization?

In trying to understand what science means, the historic aspect offers one good way of approach. From what we know of primitive man, it is safe to conclude that one of his primary difficulties was to distinguish between natural and supernatural in the world about him. In prehistoric man, as likewise among the uncivilized races of historic times, there seems to have been a widespread tendency

to regard all of nature as mysterious in character, and subject to the caprices of superhuman agencies. During the long ages of groping upward in human evolution there came but slowly the dawning recognition of some kind of regularity and order in the way things happen. Especially the more unusual and threatening events, such as storms and pestilence, were once almost everywhere regarded as supernatural and directly controlled by powerful deities. Even to-day and among the most civilized peoples, prayers for rain are still sometimes offered.

The historic evolution of medicine forms an especially striking example. The greatest achievement of Hippocrates was his then novel doctrine that disease is due to natural and not to supernatural causes. Strangely enough, however, even the most enlightened peoples have been slow and reluctant to accept this principle. Down to comparatively recent times the cause of insanity has been very commonly believed to be possession by devils. And today many otherwise apparently intelligent individuals still reject some of the most firmly established doctrines of medical science. Considering the history of mankind as a whole, we must recognize that science has had a long, uphill fight for recognition against the mental inertia and human prejudices which favor the mystical interpretation of nature.

As to the methods by which our knowledge of nature has grown, we know but little of the earlier stages. The beginnings among primitive men were doubtless mainly by the aimless, blundering paths of "trial and error." The Greek philosophers were apparently the first to delve more deeply into the study of nature. Through their incomparable genius, two important ways of investigation were found. Plato, recognizing the imperfections of the human senses, rejected their guidance and sought to discern the fundamental truths of existence through reasoning bases upon intuition. Aristotle, on the contrary, recognized the value of observation as well as reason, thus foreshadowing the scientific method.

Corresponding to these two different points of view, two divergent modes of study ultimately developed. Throughout ancient and medieval times, Plato's view largely prevailed, with emphasis on the use of intuition and reason as the basis of investigation. The result was the elaboration of extensive systems of philosophy.*

* Originally and during a long period of time, almost down to the nineteenth century, the terms science and philosophy were practically synonymous, both including knowledge in general.

The philosophers generally concentrated their attention upon moral and metaphysical problems. Their interest in nature was secondary in character, and concerned chiefly the ultimate essence of things.

This primary problem of metaphysics was clearly defined by Descartes, whose dualistic doctrine divided all phenomena into two fundamentally different fields: The mathematical, material world on the one hand and the non-mathematical, mental world on the other. Objections to his doctrine of psycho-physical parallelism, and especially the difficulties encountered in connection with the problem of interaction between the two spheres, led to rival monistic theories. These are materialism, which explains mind in terms of matter; and idealism, which explains matter in terms of mind. However, in spite of centuries of intensive study by the ablest thinkers, the classical problem of metaphysics still remains unsettled and apparently insoluble. A more recent and wholly different trend in philosophy will be mentioned later.

Down to the time of the Renaissance, speculative philosophy prevailed and the direct study of nature was greatly neglected. Then came the relatively rapid rise of science (in the modern sense of the term), that has revolutionized our views of the universe, and has marvelously increased our comprehension and control of nature. This progressive development of science has occurred in widely different fields and by the use of varied methods. These scientific methods have utilized certain principles that may be outlined as follows.

1. The directly observed facts of experience constitute the only reliable basis of knowledge. Science appeals to nature and not to authority. And to attain purely objective data, human prejudices must be excluded, so far as possible. These principles may seem obvious to scientific workers, but they are not yet clearly recognized or accepted by mankind at large.

2. The collected facts must be classified according to their interrelationships. The more important and constant of these relationships are ultimately formulated as the so-called "laws of nature." These laws, however, are never to be considered as fixed and final, but are always subject to future revision. Every new discovery on any topic makes possible still further advances in the continuous growth of science.

3. These so-called laws must be repeatedly tested by the process of prediction and verification. This testing procedure applies

likewise to the numerous preliminary stages where, through constructive imagination, temporary gaps in knowledge are bridged by tentative hypotheses. These working hypotheses also must be verified, with necessary modifications, or rejected and replaced by substitutes that may prove more satisfactory in the light of subsequent experience. In using hypotheses, scientific methods approach the realm of philosophy, as will appear later.

4. In the search for scientific knowledge, progress is greatly facilitated by careful and accurate measurement of the things observed. Quantitative studies were applied very early in astronomy, later extended to the whole group of physical sciences, and more recently to biology. This method has been so strikingly successful in these varied fields that many eminent scientists have agreed with Leonardo da Vinci that "No human investigation can call itself true science unless it comes through mathematical demonstration."

But this statement is clearly overdrawn. Mathematics, in scientific study, is a tool of priceless value and unlimited promise; but it is not an absolute essential. No definition of science can be acceptable which would exclude Darwin and Pasteur. Even in physics, Faraday managed to make some highly important discoveries in electromagnetism without the aid of mathematics. In fact, Faraday is said to have boasted that he never made a mathematical calculation in his life, except once when he turned the handle of a calculating machine.

5. Another procedure that is largely responsible for modern scientific progress is the experimental method. Passive observation, classification, and even mathematical treatment of uncontrolled phenomena have distinct limitations. When used alone, they have been found inadequate in many respects and in most fields of nature. Through experiment, however, the investigator actively interferes with the ordinary course of events, and establishes more favorable conditions, representing controlled experience. In analyzing complex phenomena, he creates artificially simplified arrangements, varying but one factor at a time while the others are held constant.

Here again, however, as in the case of mathematics, while recognizing the great value of the experimental method, we cannot agree with those who claim that only experimental work is truly scientific. Poincaré's dictum that "experiment is the sole source of truth" is therefore an exaggeration. Purely descriptive nature study, even

though limited in its possibilities, has led to some fundamental scientific generalizations. The absurdity of the experimental criterion is apparent when we consider that it would exclude as non-scientific the discovery of most of the astronomical laws and the establishment of the biological theory of evolution.

From the foregoing principles, we may characterize scientific methods as those which employ the observation, classification, and organization of facts into verifiable laws, chiefly by aid of mathematical and experimental procedures. Some other general characteristics of science may now be reviewed. It is often assumed that truly scientific laws must have universal validity; that is, they must be fully acceptable to all normal minds familiar with the data involved. This acceptability, however, is subject to certain reservations. The evidence is never complete and there is usually a fringe of more or less conflicting observations that are open to different interpretations. Since our scientific laws represent merely approximations, it seems better to consider universal validity as a desirable ideal rather than a necessary postulate of science.

Another related assumption is frequently held to be an indispensable hypothesis in scientific research. This is the doctrine of mechanistic determinism in nature. We owe to the Greeks the idea that the natural laws are fixed in character, although apparently the concept was not fully elaborated until modern times. According to this idea, the state of the entire universe at any given instant is a necessary result of the immediately preceding state and in turn predetermines the following state. This implies that the sequence of natural phenomena is invariable, so that "the same causes always produce the same effects."

Now while this principle of universal determinism is unquestionably of heuristic value as a working hypothesis, it does not appear to be indispensable to the existence of science. It is conceivable that there may be phenomena at present (and possibly forever) outside the range of science. This seems to be assumed, although not proved, by the vitalists in biology. Even in physics a principle in some respects similar is involved in Heisenberg's theory of electronic indeterminism, which Eddington ranks in importance with Einstein's principle of relativity. But even if the doctrines of vitalism and electronic indeterminism should ultimately prove tenable, they would not destroy the validity of scientific research, but would merely limit its scope in the fields of biology and physics.

At present it seems wisest simply to admit that we do not know how far the principle of determinism may hold in nature. Possibly all phenomena may to some degree be subject to indeterminism. But the scientific limits, if such exist, should be established in all cases so that we may know within what range things do happen in orderly manner. One important function of science is thus to determine the probability of events. This probability, under various circumstances, may range from practical certainty on the one hand to complete uncertainty on the other. In estimating probabilities, however, scientists are still quite justified in working on the mechanistic hypothesis which has proved so fruitful in the past.

Along with the scientific methods and principles, the motives and purposes of science may also be considered. Why do men strive to penetrate the secrets of nature? This question has been answered in two ways. In the first place, according to the utilitarian theory, scientific knowledge is widely sought because it is known to be useful in the promotion of human welfare. On the other hand, it is also clear that scientific curiosity is a trait deeply implanted in human mentality. Almost universally keen in childhood, it seems usually to fade out more or less in adult life. Yet the researches of great scientists are for the most part undoubtedly pursued primarily for the sheer joy of learning, quite aside from any thought of material utility. The Greek philosophers felt this intellectual zest so strongly that they considered the application of knowledge to useful purposes as unworthy and even degrading in character. In some quarters, traces of this scornful attitude have persisted even down to the present, as in the assumed superiority of the so-called "pure" science over the "applied" variety.

And yet these two theories of scientific motive are not so conflicting as has been generally supposed. In a broad sense, the pursuit of scientific research even for intellectual pleasure is useful; and, indeed, in a double manner. It is useful to the scientist himself, because it satisfies his curiosity. It is also useful to the race, since, whatever the motive behind the discovery, the increased insight into nature makes possible a more extensive control for the benefit of mankind.

Having in mind the methods and purpose of science, we come now to the question as to what branches of knowledge can be fairly classified under this category. Following the scheme of Descartes, the material world might be considered as the province of science,

and the psychic or spiritual world as the exclusive domain of philosophy. But such a division of the field of knowledge would satisfy neither the scientists nor the philosophers. On the scientific side the biologists, especially since the establishment of the theory of evolution, have gradually accumulated a mass of evidence indicating the essential unity of the organic world. Man appears clearly related to the other living organisms, and subject to the same fundamental laws of nature. It has furthermore become apparent that mind is closely associated with neuro-physiology. Psychologists therefore are now tending more and more to declare their independence from the traditional philosophy and to establish themselves primarily as biologists. If biology is a legitimate science, why not psychology, which is inseparable from biology? And if psychology can be a science, why not sociology and education, which are based largely upon psychology, and are earnestly striving to establish their doctrines and procedures on a scientific foundation?

Psychology may perhaps fairly be considered as the "storm center" of the present controversy. A recent critic (Schiller) summarizes the situation somewhat pessimistically as follows: "As a good example of a science hung up for ages in a manner strongly suggestive of a lack of appropriate conceptions, we may consider the sad case of Psychology. Here we have a science of apparently enormous potentialities, of universal interest, of great antiquity, upon which many generations of thinkers have lavished much time, ingenuity, and enthusiasm. Yet disappointingly little has been made of it. After more than 2000 years of strenuous cultivation, it still has no laws but only technical terminologies; no consensus about methods and principles, but a swarm of discordant 'schools;' no definite limits and no assured territory but far-reaching claims and perpetual border-wars with all its scientific neighbours. It has 'descriptions,' but none adequate to the subtleties and shades of the processes they describe; nor has it any real control of the mind and the power to predict its operations. Indeed, it does not seem quite sure even that it has got a mind, any more than that the 'soul' exists, from which it draws its name. For one of its latest fashions is seriously endeavouring, under the flag of 'Behaviourism,' to construct a psychology from which the conception of consciousness has been eliminated altogether."

While this judgment may seem unduly severe, other critics, using the mathematical criterion, would even deny the possibility that

psychology can ever be a science at all, on the ground that psychic phenomena are unmeasurable and therefore non-scientific. This criticism might be met first by a denial (for the reasons before mentioned) that the mathematical criterion is justified. In the second place, mental phenomena *can* undoubtedly be measured, though not at present in exact quantitative fashion. Sensations, for example, differ in intensity, and can be profitably measured and compared, using various methods. Fechner's law illustrates the possibilities of such study. Memory and other psychic characters can certainly be measured in various ways as has been amply demonstrated by experimental psychology in recent years.

As to behaviorism, it must be admitted that the extremists, who deny the existence of consciousness, have taken an apparently defenseless position; for without "psyche" there is certainly no real psychology. In this extreme behavioristic sense, psychology is reduced to merely a subordinate branch of physiology. A more reasonable contention in favor of behaviorism, from the standpoint of psychology, would appear to be this. Mental phenomena, which are difficult to study directly, are somehow correlated with the state of the physical organism and especially of the nervous system, whose activities are more conveniently accessible to observation. Therefore the psychologist may deliberately investigate behavior in the hope that he may thereby ultimately learn more about the associated psychic phenomena which constitute the real and special field of psychology.

On the whole, it appears to me that, with or without behaviorism, psychology is amply justified in claiming a place in the scientific sun. Surely it is absurd to exclude the scientific study of the mind, that through which all science is made possible. And furthermore it seems reasonable to assume that ultimately all the social sciences, including even ethics, esthetics, and religion, will prove amenable in some degree to scientific treatment. I would, therefore, again disagree with Poincaré, who asserts that "scientific truth, which is demonstrated, can in no way be likened to moral truth, which is felt." Much more reasonable is the conclusion of Clifford that "the subject of science is the human universe."

We must, of course, freely admit that scientific methods are not able at present to penetrate very deeply into some of the social sciences. As Lewis puts it, "The hardest study of mankind is man." But these methods should in all cases be given encouragement and

a fair chance. After all, science apparently offers the only hope for a satisfactory solution to many social problems with which we are all deeply concerned. Sooner or later, in all fields of science, we reach the limits of verifiable knowledge. There we must join hands with philosophy, which by speculative means seeks to penetrate more deeply into the surrounding vast unknown. Philosophy thus embraces the more general and more nearly ultimate problems that are beyond the reach of scientific methods.

According to this conception, science and philosophy together cover the field of the universe. But the dividing line between them is not vertical, separating some branches exclusively scientific from others exclusively philosophic. The division is rather to be thought of as horizontal in character. All branches of knowledge have a lower zone of verifiable, scientific facts and laws, and a higher zone, as yet unverifiable, of philosophic hypothesis. Thus scientists and philosophers should be co-workers rather than rival contestants in the study of nature. "Only where science leaves off does philosophy begin" (Jenkinson).

The level of this division plane, however, is extremely uneven in the various fields of knowledge. In the psychic and social sciences it is yet relatively low, with correspondingly slight scientific basis and enormous proportion of philosophic superstructure. In the physical sciences the converse is perhaps true, while in biology the conditions in general are somewhat intermediate. Moreover, the boundaries are not fixed but always movable; and it is the function of scientific research to raise the level and enlarge the sphere of science, encroaching upon the surrounding area of philosophy. The zone of philosophy is upwardly boundless, however, so there is no occasion to quarrel concerning the territorial border-lines.

The realization of such a conception of co-operation with science would appear to be facilitated by recent trends in philosophy, and especially by the pragmatic movement. Philosophic interest seems lately to be shifting somewhat from the hopelessly abstract theories of metaphysics to the more concrete problems of every-day life. The pragmatic doctrine that "truth is that which works" represents a revolutionary attitude that tends to bring philosophy down from the clouds into a position alongside of science in solving the practical problems of mankind. Indeed, to those who still think in classical terms, it must seem quite strange to consider philosophy as the immediately practical guide of life, relegating science to a somewhat

more remote and conservative position (as recently proposed by Kelley).

In any event, a rational division of labor between science and philosophy would be useful to both, and the future in this respect looks hopeful to all concerned. This recent tendency should be welcomed by a liberal and progressive spirit on the part of scientists in general and of Sigma Xi in particular. Established for the promotion of scientific research, the Society has wisely been cautious in not restricting the term science to any specific fields of knowledge. Although the question has been raised from time to time as to what sciences are appropriate for recognition by Sigma Xi, the matter has properly been left to the various local chapters, to be decided as the individual cases may arise. And this excellent rule should be continued, for it permits a liberal policy on this issue that will tend to promote the future growth and development of science.

We may justly be proud of the success and progress already made through the application of scientific methods in various fields, and we should demonstrate our confidence in these methods by encouraging their extension whenever and wherever possible in all branches of thought. We can do this by recognizing individual accomplishment in research which enlarges the field of verifiable knowledge in any direction whatsoever. On this broad basis of eligibility, the number of candidates for Sigma Xi from the social sciences will probably be relatively small for a long time to come. Moreover, the candidates working in the borderline territories of science will properly be subjected to an unusual degree of scrutiny, for the burden of proof will always rest heavily upon the newcomers. My plea is merely that in this matter we should be open-minded and tolerant. For thereby we can best promote scientific progress and can hope to justify the realm of science as that of all verifiable knowledge of the universe.

# REPORTS (IN ABSTRACT) FROM HOLDERS OF SIGMA XI RESEARCH GRANTS FOR 1929-30*

DR. ROBERT GRANT AITKEN, Associate Director of the Lick Observatory at Mt. Hamilton, California, was granted $500 to aid in the preparation of a general catalogue of double stars with computations. The award was used by Dr. Aitken in meeting in part the stipend of an assistant. He writes that the manuscript for the double star catalogue is ready for the printer. A general check of the whole manuscript was made during the spring months, and it was finally sent to the Carnegie Institution at Washington, which is to publish the work. Dr. Aitken expresses his gratitude for the assistance rendered by the SOCIETY in enabling him to accomplish this important piece of work.

PROFESSOR ARTHUR A. BLESS, University of Florida, Gainesville, Florida, was granted $250 for the purchase of apparatus for the study of the phenomena of dielectric absorption in relation to the theory of Debye. Professor Bless worked on the polarization and the electric moment of tung oil. The polarization of a substance is the result of the distortion of the molecules due to electronic displacements produced by the field, and of the orientation of the polar molecules in the impressed field. At very high frequencies the molecules are no longer able to follow the field, and the contribution to the polarization, due to the oriented molecules, vanishes. By determining both the density and the dielectric constant of solutions by very careful measurements, and applying the measurement to an equation deduced from the Clausius-Mosotti relation, Dr. Bless found that this equation may be applied to the whole range of concentrations of solutions of tung oil in benzene, which he used for his study, and that the interaction of the molecules is in this case negligible.

In a second set of experiments the dielectric constant of tung oil as a function of temperature was studied, with interesting and important results. When measured at high frequencies the dielectric constant of tung oil decreases with increasing temperature, but the decrease takes place only when the temperature is above 23° C. When the frequency of the impressed field is $1.47 \times 10^6$ there is a decided increase of the dielectric constant for temperatures lower

* Note: Reports as received are on file in the office of the National Secretary.

than 23°. Apparently for a given frequency of an impressed field a temperature may be reached for which the viscosity of the liquid is so great that the molecules are no longer able to follow the field, and the contribution to the dielectric constant, due to the orientation of the molecules, is beginning to diminish. Since tung oil freezes at about 250° absolute temperature, the dielectric constant of the solid tung oil is shown by measurements of Dr. Bless to diminish with decrease in temperature in about the same manner as when in a liquid state. The inference might therefore be drawn that even in a solid the molecules have a certain freedom of motion, and that the solid and liquid states do not present a discontinuity so far as molecular rotation is concerned. The notion of molecular rotation in a solid was advanced first by Errera in order to explain the existence of anomalous dispersion in the solid state. While it seems rather difficult to conceive of molecules having such a freedom when in a solid body, the explanation is plausible. Dr. Bless suggests that a way of testing the theory would be to get diffraction patterns of polar compounds when under steady fields, and when under the influence of slowly varying fields. The regularity which might exist in the first case should completely disappear in the second. Such a method would furnish the upper limit of the relaxation time of the molecules, since for some very high frequencies the molecule would retain its orientation if the field alternations are too great for it to follow.

Dr. Bless has prepared a paper on the composition of the interior of the earth, in which he was indirectly aided by the Sigma Xi grant. Dr. Bless sends parts of his reports with certain minor changes to the editor of the Proceedings of the National Academy of Sciences for publication, and states that, as is the case with every piece of research work, interesting questions are raised by the work he has already done, and he proposes during the coming academic year to study some of these questions; namely, the existence of molecular motion in solids, and the variation of the maximum of the dielectric constant with temperature and with frequency. In his report Dr. Bless expresses his appreciation of the grant made him by Sigma Xi.

A grant of $1000 was made to PROFESSORS H. CLARK, J. MURRAY LUCK, and C. V. TAYLOR, of Stanford University, for investigating the selectivity of differentiated structures of living cells to x-rays of known intensity and frequency. The introductory biochemical

work on the problem was focused upon a study of the role of bacteria in the nutrition of Euplotes. The aim was the elaboration of a simple synthetic medium in which Euplotes would grow upon a known and single strain of bacteria, and if possible in the absence of all bacteria.

Starting from a crude medium consisting of crushed wheat in natural sea water, and a mixed bacterial flora from the air and wheat, a simple basal medium was developed, consisting of 0.01% glucose in 1:1 artificial sea water. Six strains of bacteria isolated from the initial cultures indicated that individually they are incapable of supporting the growth of Euplotes Taylori. *B. coli communis* is likewise unfit, but excellent results were obtained by the use of a pair of bacterial strains; namely, *B. coli communis* and one of the six organisms above mentioned. With these two bacterial species in the basal medium, thriving cultures of Euplotes, 10,000 to 20,000 organisms per cc., have been obtained.

A satisfactory method of ridding Euplotes of all bacteria was developed. The procedure is in principle that of Hargitt and Fray. It consists in the washing of ten protozoa through twelve successive baths of sterile artificial sea water. The sterility was checked by making four plates of the entire last bath, including the protozoa.

The nutritional significance of bacteria was also investigated by endeavoring to feed Euplotes upon heat-killed bacteria, autolyzed bacteria, bacterial dialysates, phagelysed bacteria, toluene-killed bacteria, and bacteria which have been exploded with carbon dioxide. None of these preparations of dead bacteria supported the growth of Euplotes. Soluble organic nutrients were also attempted under strictly sterile conditions from simple carbohydrates and amino acids to blood serum without results. In the latter experiments bacteria were rigidly excluded, the sterile Euplotes used as the inoculum.

Professor Luck writes that they are now engaged in the study of other bacteria as food, the sterilization and chemical resistance of Euplotes cysts, and the development of precise quantitative methods for following the multiplication of protozoa and bacteria in their cultures. He regards all his experiments as a necessary preliminary to the x-ray irradiation of the organisms.

The living cell Euplotes was chosen for the study because of its highly differentiated and well-defined structures, and also because of the knowledge of its cyclic changes during cell division, conjuga-

tion, encystment, and excystment, and regeneration. One of the group (Professor Taylor) limited his part of the collaborative program to the investigation of the normal cell life of the Euplotes. It has been found that in this ciliate Euplotes, whose encystment can be induced at will, there persists some and perhaps all of its locomotor organs, although partial dedifferentiation of these does obtain. This added knowledge is considered of first importance for the experimental investigation under way.

The ciliate Euplotes possesses a well-defined fibrillar apparatus which apparently functions in the co-ordination of its locomotor organelles. Recent studies indicate fairly conclusively that this reorganization of this fibrillar system occurs during cell cycles.

It should be stated further that the species of Euplotes on which the work is being done is new, having been found in the laboratory of this group within the last two years. A considerable amount of comparative studies is required for the complete biology of this species, and these studies are being continued, supplementary to the experimental phases of the general problem.

Appreciation of the award of Sigma Xi for a study of this important project is expressed by the group.

PROFESSOR WILLIAM HARDER COLE, Rutgers University, was granted $200 to purchase apparatus to study the effects of various gases—carbon monoxide, carbon dioxide, oxygen, nitrogen, etc.—on the respiratory activities of animals. Special apparatus, including a large and accurately regulated thermostat, was required for the investigation of the general problem of chemical stimulation. During the year stimulating efficiencies of the first five normal primary aliphatic alcohols were studied in the barnacle, the frog, and the planarian. The data have been analyzed, and a preliminary theoretical interpretation has been made. A report of the work is in preparation for publication this fall, and the paper contains grateful acknowledgment of the grant from Sigma Xi.

PROFESSORS WHEELER P. DAVEY AND W. R. HAM, Pennsylvania State College, were granted $1000 for investigating the conductivity of insulators under electronic bombardment. The entire sum was spent as a stipend of an assistant, who conducted the experimental work, and was supplemented by sums granted by the Department of Physics of the State University. Positions of atomic energy levels were determined by earlier experiments in which a number of Coolidge water-cooled x-ray tubes were used, and this work gave

evidence indicating an increase in the electrical conductivity of the glass walls of the tubes when bombarded by electrons reflected from the anodes. The phenomena was of such interest and importance as to make it seem advisable to study it more intensively, and with apparatus especially designed for the purpose. A great deal of time and very careful work was required to prepare the apparatus, and a report of the experiments already done is preliminary in nature. The problem is a lengthy one and much work is necessary before final and complete results can be obtained. A large number of insulators will have to be studied, each under more widely varying impressed potentials and electron bombarded densities than have been possible with the use of the present apparatus. With the potentials and intensities of bombardment possible, and in the light of difficulties in construction encountered, an interpretation of data obtained up to the present indicates that the change in conductivity of the pyrex glass used in the apparatus under bombardment is very small, if it exists at all. These results will not be conclusive until further work has been done with the tube which eliminates as far as possible the difficulties experienced in the present tube. Two such tubes are now in process of construction, each of which is designed to allow operation at voltages considerably higher than those previously possible, and it is expected that the results will be of greater reliability.

The work will be continued during the academic year 1930–31 with additional apparatus generously supplied by certain manufacturers. When definite results are obtained a complete report of the work is promised, and in that report the assistance of Sigma Xi will be publicly acknowledged.

Miss Joyce Hedrick, Miami University, Oxford, Ohio, was granted $300 for continuation of work on Dr. Fink's manual of "Lichen Flora of the United States." This grant was a renewal of awards previously made, and was supplemented, as were the others, by similar amounts from Miami University. Miss Hedrick used this particular grant for expenses during time spent in preparing descriptions for final typing, and checking material in the University of Michigan Herbarium for additional distribution and additional genera and species; also in part for expenses while studying Lichen material in the Field Museum in Chicago; and also for typing manuscript and proof-reading. Miss Hedrick, Miami University, and the many friends of Dr. Fink, in whose memory the manual

is being carried to completion, express appreciation to Sigma Xi for the help it has given this work.

MISS DOROTHEA EGLESTON SMITH, Bryn Mawr College, was granted $200 for work on a micro-titration method for the determination of free fatty acids in cells, with especial reference to work done on cytoplasmic inclosions. She writes that the work has taken longer than was expected. Apparatus has been purchased and a start made on the problem, and an official report will be made later.

PROFESSOR THOMAS H. GRONWALL and VICTOR K. LAMER, Columbia University, were granted $500 as a part stipend of an assistant for numerical computation of tables to compare the Gronwall-LaMer theoretical formulas with experimental data on the Debye and Hückel theory of the solutions of strong electrolytes. At a very early stage of the work it was found more desirable to concentrate effort on looking up the unsymmetrical case (ions of unequal valence, as in $MgCl_2$ or $K_2SO_4$), rather than striving for further refinements of the previous treatment of the symmetrical case on the part of these men. One reason for this was the length of time required to get entirely satisfactory numerical results in the latter case. Still more important, however, was the necessity of meeting the incessant demands in recent literature for numerical results applicable to the unsymmetrical case. The numerical work on the theory of the unsymmetrical case has been carried out to the terms of the third order inclusively, and the agreement with the experimental data is thoroughly satisfactory. This comparison of theory and experiment has been carried out on all the available data on electromotive force and freezing point depression of unsymmetrical electrolytes, as well as on typical cases of solubility determinations. A close agreement has been found possible, without taking into account the fourth and fifth order terms.

The authors are preparing a paper on these results, which is to be offered to the *Physikalische Zeitschrift*, which published their first paper on the subject. The authors express gratitude for the grant from Sigma Xi, without which the work could not have been done.

# SIGMA XI RESEARCH AWARDS FOR 1930-31

REPORT OF COMMITTEE ON SIGMA XI GRANTS FOR 1930–31

The Committee makes the following awards for the academic year 1930–31:

*Professor Arthur A. Bless*, University of Florida, Gainesville, Florida. $250 for continuation of research on the phenomena of dielectric absorption in relation to the theory of Debye.

*Professor Jean Broadhurst*, Teachers College, Columbia University. $700 for investigating the life-cycle phases of an exceedingly variable organism, isolated from the mouth of a recent visitor from Palestine.

*Miss Joyce Hedrick*, University of Michigan. $300 for the continuation of work on Dr. Fink's "Lichen Flora of the United States."

*Professor Norman Ethan Allen Hinds*, University of California. $450 for the study of Hawaiian lavas for use in a report on the petrography of the igneous rocks of Kauai and Niihau.

*Dr. Icie G. Macy*, Merrill-Palmer School and Children's Hospital of Michigan, Detroit, Michigan. $450 for the completion and publication of the results of an investigation of the calcium and phosphorus metabolism of women in late lactation.

*Professor Arthur H. Smith*, Yale University. $700 for study of the changes in chemistry and morphology of the blood induced by feeding diets poor in inorganic salts.

*Professor William Randolph Taylor*, University of Pennsylvania. $200 for publication of plates requiring more accurate detail than possible with ordinary half-tone.

EDWARD L. THORNDIKE,
Professor of Psychology, Columbia University
JOHN H. NORTHROP,
Rockefeller Institute for Medical Research
ARTHUR M. GREENE,
Dean of the School of Engineering, Princeton University

# INFORMATION FOR CHAPTERS AND CLUBS

## I. Chapter Activities

The Secretary's office is constantly in receipt of enquiries from chapters and clubs regarding the activities of the Society, especially in connection with chapters and club meetings. The following from the Ohio chapter is typical:

"The local executive committee feels that the function of the Society of the Sigma Xi in the past has largely been the sponsoring of scientific lectures. During the past few years here at Ohio State that function has largely been usurped by the Graduate School. Since the Graduate School has a great deal more money available for this purpose than has the Society of the Sigma Xi, it seems useless to attempt any competition. For this reason a smaller and smaller number of lectures have been sponsored by the Chapter each year. ...If the policy of sponsoring lectures is to be given up then it would seem necessary to have the Society serve some other function. ...We will be grateful if you will furnish us information and suggestions as to the proper field of action for the local chapter."

The secretary responds to all such enquiries and requests with more or less lengthy letters, in which he endeavors to set forth chapter activities. They are many and varied, and among them are to be found rich suggestions for all chapters which, like Ohio, are faced with the wisdom of changing long established and traditional practices.

All chapters and clubs are directly and profoundly interested. Following are some of the activities practiced by different chapters in furthering the object of our great organization, "the promotion of research."

1. *Offering Research Prizes for Work Accomplished.* The Ohio Chapter itself has an endowment fund of $1000, the income from which, as it is, or enlarged as the Chapter is contemplating, could properly be used as a research prize. Several Chapters already have such prizes and in the case of one the award is made by a committee appointed by the National President of Sigma Xi, it being understood that no member of the Chapter is eligible to appointment on the committee.

2. *Offering Research Fellowship to Promising Recently Elected*

*Members.* This enables such students to continue work in a graduate school, either in the university in which the chapter exists, or in some other of the student's choice.

3. *Making Contribution to the Research Fund Maintained by Sigma Xi Alumni under the Auspices of the Alumni Committee.* This fund, to which reference is made in every September issue of the QUARTERLY (see page 93 this issue) is distributed by a committee of well-known scientists, only one of whom is an officer of the society. Such is the policy of small chapters in institutions in which the research output is necessarily limited. While the National officers and the alumni committee appreciate the help and spirit of such contributions, they feel it is better, where conditions invite it, for chapters to give their financial support to research in their own institutions.

4. *Holding Meetings.* The number of such meetings will of course depend on local conditions. At all large institutions where conditions are similar to those at Ohio State, meetings are held and the programs vary, but all are important and influential. In some instances only one or two meetings in addition to a business meeting are held. They are made "scientific events" and are addressed by men of national and international repute. In a few cases chapters geographically near each other combine in the plan and a lecturer delivers lectures in succession at each. Chapters frequently hold meetings under the auspices of a department, and the meetings are occasions for the department to tell about the research in progress in it, to exhibit its facilities for research, or to recount important advances in knowledge in its particular field.

A few chapters take up a special topic for the year, and ask their own members or visitors to lecture on such topic. As far as the secretary's office has information Yale Chapter originated the plan with a series of five lecturers on "The Evolution of the Earth and Its Inhabitants" in 1916–17, which was followed by a similar series of six lectures on "The Evolution of Man," in 1921–22. Both these series were later published by the Yale University Press.

Other chapters have done or are doing the same thing; Missouri and Minnesota have each published at least one such series. (See page 108, this issue.)

The above are some of the activities of the chapters. Among them all chapters will find suggestions which may be of help in arranging their programs for the ensuing academic year.

## II. Available Lecturers

Repeated requests from chapters have come to the Secretary to submit a list of possible lecturers and topics for chapter or public gatherings. In order to supplement his personal information, the Secretary sent a letter to all chapter presidents and secretaries in the early Spring, from which the following is an excerpt:

"The Secretary's office is frequently called upon to name available speakers and appropriate topics both for chapter meetings and public addresses at educational institutions. What is desired is scientific lectures on lively topics and couched in language that will be understood by intelligent audiences who have not, necessarily, an acquaintance with the technical terms of other fields than their own.

"Will you be good enough to send me the names of some members of your chapter who would be available to give such scientific addresses, and also topics on which they would speak?"

A number of replies were received. The names of the lecturers given follow:

### AVAILABLE SPEAKERS FOR SIGMA XI MEETINGS

1. MATHEMATICS:
   - Dr. E. T. Bell—Calif. Inst. of Technology, Pasadena, Calif.
   - Dr. Louis Brand—Univ. of Cincinnati, Cincinnati, Ohio
   - Dr. Charles N. Moore—Univ. of Cincinnati, Cincinnati, Ohio
2. PHYSICS:
   - Dean L. T. More—Univ. of Cincinnati, Cincinnati, Ohio
   - Dr. F. K. Richtmyer—Cornell University, Ithaca, N. Y.
   - Prof. E. C. Watson—Calif. Inst. of Technology, Pasadena, Calif.
3. CHEMISTRY:
   - Dr. E. M. Chamot—Cornell University, Ithaca, N. Y.
   - Dr. Martin H. Fischer—Univ. of Cincinnati, Cincinnati, Ohio
   - Dr. H. S. Fry—Univ. of Cincinnati, Cincinnati, Ohio
   - Dr. William Houston—Calif. Inst. of Technology, Pasadena, Calif.
   - Prof. Maurice L. Huggins—Stanford University, Calif.
   - Dr. A. P. Mathews—Univ. of Cincinnati, Cincinnati, Ohio

Dr. G. D. McLaughlin—Univ. of Cincinnati, Cincinnati, Ohio
Dr. L. C. Pauling—Calif. Inst. of Technology, Pasadena, Calif.
Prof. Herman Schlundt—Univ. of Missouri, Columbia, Mo.

4. ASTRONOMY:
Dr. John Anderson—Calif. Inst. of Technology, Pasadena, Calif.
Dr. S. L. Boothroyd—Cornell University, Ithaca, N. Y.
Prof. Eli S. Haynes—Univ. of Missouri, Columbia, Mo.

5. SCIENCE OF THE EARTH:
Prof. E. B. Branson—Univ. of Missouri, Columbia, Mo.
Dr. G. M. Butler—Univ. of Arizona, Tucson, Ariz.
Dr. A. E. Douglass—Univ. of Arizona, Tucson, Ariz.
Dr. J. S. Joffe—Rutgers Univ. Exp. Station, New Brunswick, N. J.
Prof. D. Keyes—McGill University, Montreal, Canada
Prof. Howard E. Simpson—Univ. of North Dakota, Grand Forks, N. Dak.
Dr. W. M. Davis—Univ. of Arizona, Tucson, Ariz.

6. BIOLOGY—Including PSYCHOLOGY:
Dr. Madison Bentley—Cornell University, Ithaca, N. Y.
Prof. T. D. A. Codkerell—Univ. of Colorado, Boulder, Colo.
Prof. W. C. Curtis—Univ. of Missouri, Columbia, Mo.
Dr. G. W. Herrick—Cornell University, Ithaca, N. Y.
Prof. F. E. Lloyd—McGill University, Montreal, Canada
Dr. D. T. McDougal—Univ. of Arizona, Tucson, Ariz.
Prof. Max Meyer—Univ. of Missouri, Columbia, Mo.
Dr. T. H. Morgan—Calif. Inst. of Technology, Pasadena, Calif.
Dr. Edwin W. Schultz—Stanford University, Calif.

7. ANTHROPOLOGY:
Dr. H. H. Love—Cornell University, Ithaca, N. Y.
Dr. George C. Wheeler—Univ. of North Dakota, Grand Forks, N. Dak.

8. MEDICINE IN ITS VARIOUS BRANCHES:
Dr. Gustav Eckstein—Univ. of Cincinnati, Cincinnati, Ohio
Dr. V. A. Moore—Cornell University, Ithaca, N. Y.

9. ENGINEERING IN ITS DIFFERENT BRANCHES:
Prof. R. R. Martell—Calif. Inst. of Technology, Pasadena, Calif.
Prof. Franklin Thomas—Calif. Inst. of Technology, Pasadena, Calif.
Prof. R. S. Tour—Univ. of Cincinnati, Cincinnati, Ohio

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## III. Special Requests to Chapters

Other requests of the Secretary to chapter officers did not meet with general response. Scientists who could, and would be willing to, write short articles for the QUARTERLY on some outstanding piece of research either of their own or of some fellow worker in their field, were sought without success.

Suggestions were urged regarding the conduct of the Society's business for presentation to the National officers, but with only one or two replies.

The QUARTERLY goes to about 10,000 subscribers. These men and women are not only profoundly interested in research work in their own particular realm, but also in research in general. They like to know what is going on in other fields of scientific endeavor. We can all be of tremendous help to each other by telling each other what is happening in our science. Contributions of this sort are desired and eagerly read.

The National officers welcome and ask for recommendations regarding the Society, its policy, and its progress. Chapter officers and members, and alumni are urged to submit suggestions and constructive criticisms. All such are given careful and grateful consideration at the two meetings which the officers hold each year. *Please communicate your ideas about Sigma Xi to the Secretary.*

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## IV. The Alumni Research Fund

Through the Spring months the Secretary's office includes in its activities the annual circularizing of about 14,000 alumni and associates under the auspices of the Alumni Committee. The committee desires by these circulars to keep this great body of scientists in touch with Sigma Xi and its objects, and at the same time to maintain a research fund which can be used in giving financial sup-

port to research workers. Some of the replies are in the form of interesting personal comments. Quotations from three such follow:

From John J. Rutledge (Sigma Xi, Illinois, 1922), Chief Mine Engineer, Maryland State Bureau of Mines:

"I take pleasure in sending my contribution.... At the same time I want to express my appreciation of membership in Sigma Xi and the excellence of the circular letter issued."

From Thomas Large (Sigma Xi, Chicago, 1903), Teacher of Zoology, The Lewis and Clark High School, Spokane, Washington:

"Scientifically this area of the Northwest from the Dakotas to the coast and south almost to San Francisco Bay is as fallow as central China. Its potential wealth is as great as, or greater than, that of any other section of the United States. The great scientific foundations have millions for Egypt, Central Africa or China but not a penny for this vastly interesting and important region. Aside from government workers in geology and mines, forestry and agriculture, our only research workers are a few underpaid college and high school teachers who struggle with over-large classes and try to get in a little time on some pet work in science.... After many years of trying to get on with an inadequate supply of microscopes, I was compelled to purchase my own (ten compound microscopes) in order to face my classes without shame. All I have to do research work with is some freedom of spare time in vacations. No support comes to it from any source.... Such is the life of a would-be scientist in the great Northwest.... Very sorry but I fear I shall not contribute much to the research fund of Sigma Xi this year."

Professor Mignon Talbot (Sigma Xi, Ohio, 1911), Mount Holyoke College, "I have not in the past thought that I wanted the QUARTERLY, because of lack of time to read it, but I am so glad you sent me the June number that I am going to ask you to send me the QUARTERLY hereafter. That article on 'Heredity' (by Professor Cole, Wisconsin) is so very good and goes so well with article in the June number on 'Evolution,' that I feel quite 'fed up' and also much enlightened. Things scientific move rapidly these days, and it is hard to keep up, particularly outside of one's own field."

## V. CHAPTER REPORTS

Reports of chapter activities for 1929–30 so far as the Secretary has received them are presented with lecturers and topics, when given, tabulated according to the list of sciences Sigma Xi represents.

This list of sciences was first published in the QUARTERLY for March, 1928, and chapter reports take this form in response to suggestions from many of our members, in order to make possible more ready reference by fellow workers to projects under way in this country and to the individuals who are prosecuting them. The Secretary regrets that reports have not been received from all the chapters. Request for reports is here repeated. They will be given the membership at large when and if received.

MATHEMATICS:

Dr. T. Dantzig, University of Maryland, "Mathematics and Experience."

Dr. R. F. Graesser, University of Arizona, "A Certain General Type of Neumann Expansions."

Professor A. W. Hobbs, University of North Carolina.

PHYSICS:

Dr. Lee de Forest, Northwestern University, "The Vacuum Tube."

Dr. Walter Soller, University of Arizona, "Some Applications of X-Rays."

Professor F. K. Richtmyer, Cornell University, see under "General."

Professor G. P. Thomson, Aberdeen University, "Electron Waves."

Professor J. G. Brown, Stanford University, "The Relation of Electric Space Charge and Potential Gradient to the Diurnal System of Convection in the Lower Atmosphere."

Professor John T. Tate, University of Minnesota, "Recent Developments in Physics."

Professor J. C. Jensen, University of Nebraska, "Recent Progress in Broadcast Transmission."

Dr. F. O. McMillan, Oregon State College, "An Investigation of Lightning and Its Relation to Forest Protection."

Professor Ernst Gellhorn, University of Oregon, "Quantitative Studies of Ion Antagonism."

Professor J. H. Johnson, University of Idaho, "History of Electrical Development."

Dr. W. W. Coblentz, Bureau of Standards, "Measurements of Stellar Temperatures."

Dr. C. E. Kenneth Mees, Eastman Kodak Co., "The Production of a Photographic Image."

Professor G. F. McEwen, Stanford University, "Theories of Ocean Currents."

Professor Ed. Browne, Professor Otto Stuhlman } University of North Carolina

CHEMISTRY:

Dr. J. E. Mills, National Research Council, "Molecular Attraction."

Dr. H. G. Knight, Bureau of Chemistry and Soils, Washington, "Research as Conducted by Government Bureaus."

Dr. Irving Langmuir, Research Laboratory, General Electric Company, Schenectady, N. Y., "Chemical and Physical Properties of Atoms and Molecules Absorbed on Surfaces."

"Oil Films on Water" (talking motion picture).

Dr. Frary, Aluminum Company of America, "The Competitive Position of the Aluminum Industry."

Professor C. W. Foulk, Ohio State University, "A New Theory of Foaming."

Professor L. C. Pauling, California Institute of Technology, "The Structure of Complex Inorganic Crystals Including the Silicates."

Profesor E. C. Franklin, Stanford University, see under "General."

Professor Lawrence B. Becking, Stanford University, "Salt."

Professor Francis Bergstrom, Stanford University, "Solutions of Metals in Non-Metallic Solvents."

Professor H. G. Grimm, Stanford University, "Atomistics and the Systematization of Chemical Compounds."

Professor S. C. Lind, University of Minnesota, "Recent Developments in Chemistry."

Professor K. Fajans, University of Munich, "Developments in the Concept of the Nature of Chemical Forces."

Dr. P. K. Devers, General Electric Company, "Fused Quartz—Its Properties and Uses."

Dr. H. B. Myers, Dr. V. T. Austin } University of Oregon, "Detection of Methyl Alcohol in the Presence of Formaldehyde."

Professor Barnett F. Dodge, Yale University, "Chemical Synthesis at High Pressure."

ASTRONOMY:

Dr. E. F. Carpenter, University of Arizona, "Our Stellar System as a Spiral Nebula."

Professor C. C. Crump, University of Minneosta, "Recent Developments in Astronomy."

Professor Harlow Shapley, Harvard University, "Order among Star Clusters and Nebulae."

"From Electrons to Galaxies."

"Super Galactic Systems."

Professor E. W. Brown, Yale University, "Time and Tide."

SCIENCE OF THE EARTH:

Professor W. G. McGinnies, University of Arizona, "Observations on the Kaibab Deer Range."

Dr. R. J. Leonard, University of Arizona, "The Weathering of Granite in a Semi-Arid Region."

Mr. Carl Lausen, University of Arizona, "A Geological Survey Trip through the Great Slave Lake Country of Canada."

Dr. A. A. Stoyanow, University of Arizona, "The Paleogeography of Arizona."

Dr. Wm. M. Davis, University of Arizona, see under "General."

Professor G. F. McEwen, Stanford University, "Theories of Ocean Currents."

Professor W. H. Emmons, University of Minnesota, "Recent Developments in Geology."

Professor W. S. Cooper, University of Minnesota, "Vegetation after the Retreat of Some Alaskan Glaciers."

Dr. E. T. Hodge, University of Oregon, "Tertiary Vulcanism of the Pacific Basin and Africa."

Professor Alan H. Bateman
Professor Chester R. Langwell } Yale University, "Some Geological Features of Central and South Africa."

Professors W. B. Cobb, W. F. Prouty, J. H. Swartz, G. R. McCarthy, University of North Carolina.

BIOLOGY including PSYCHOLOGY:

Dr. H. J. Patterson, University of Maryland, "Grass."

Professor Philip Fox, Northwestern University, "Planetaria."

Professor J. J. Thornber, University of Arizona, "Interesting Introduced Plants of Arizona."

Dean E. M. Freeman, University of Minnesota, "The Work of the Minnesota Laboratory on the Physiological Farms of Wheat Rust."

Dr. Forrest Shreve, University of Arizona, "The Influence of Soil Conditions on the Distribution of Desert Vegetation."

Mr. E. J. Crider, University of Arizona, "Roots."

Dr. J. E. Markee, Stanford University, "Some Specific Vascular Changes in the Uteri of Mammals."

Professor E. W. Schultz, Stanford University, "The Ultrascopic Viruses from the Biological Standpoint."

Dr. E. C. Kendall, Mayo Foundation, "The Thyroid Gland."

Professor R. E. Coker
Professor J. M. Valentine } University of North Carolina
Professor Alan Mozley

Professor Leunis Van Es, University of Nebraska, "An Enzootic Liver Disorder of Livestock Caused by a Poisonous Plant."

Professor H. C. Cottle, University of Nebraska, "Results of Overgrazing in S. W. Texas."

Professor A. E. Holch, University of Nebraska, "Development of Forest Trees in Three Habitats."

Professor J. Arthur Harris, University of Minnesota, "In Desert and Rain Forest."

Professor T. C. Nelson, Rutgers University, "Recent Progress in Oyster Investigations."

Professor Louis F. Henderson, University of Oregon, "Ramblings of a Botanist."

Dr. W. T. Johnson, Oregon State College, "Coccidiosis in Chickens."

Professor W. H. Pierce, University of Idaho, "Plant Diseases of Wheat, Potatoes and Beans."

Professor H. B. Stough, University of Idaho, "Contributions of Zoology to Science."

Professor F. W. Gail, University of Idaho, "Historical Development of Botany."

Professor L. J. Cole, University of Wisconsin, "Sex Determination."

Professor E. E Hubert, University of Idaho, "Micro-Organisms in Industry."

Professor E. W. Lindstrom, Iowa State College, "Modern Tendencies in Genetics."

Dr. Donald F. Jones, Connecticut Agricultural Experiment Station, "The Application of Genetics to Plant Improvement."

Professor Felix D'Herelle, Yale University, "The Bacteriophage in Nature."

Professor J. F. Dashiell
Professor English Bagby } University of North Carolina
Dr. Mabel E. Goudge

MEDICINE:

Dr. N. C. Gilbert, Northwestern University, "The Coronary Arteries in Angina Pectoris."

Dr. J. C. Hinsey, Northwestern University, "The Cathode Ray Oscillograph Applied to the Study of Nerve Action Potentials."

Dr. H. B. Kellogg and Dr. L. W. Dowd, Northwestern University, "Motion Pictures Showing Motility of the Stomach."

Dr. W. J. Meek, University of Minnesota, "Research Studies on the Heart."

Dr. H. A. McGuigan, University of Illinois, College of Medicine, see under "General."

Dr. Ernst F. Muller, University of Illinois, College of Medicine, "The Skin as a Vegetative Sense Organ."

Dr. I. Pilot, University of Illinois, College of Medicine, "Experimental Lung Abscesses."

Dr. A. K. Boor, University of Illinois, College of Medicine, "Specific Specificity of Carbon Monoxide Hemoglobin."

Dr. H. H. Jaffe, University of Illinois, College of Medicine, "Histological Studies of Coccidioidal Granuloma."

Dr. W. F. Petersen, University of Illinois, College of Medicine, "Lymph Changes Following Bulbus Pressure in Dogs."

Dr. Lloyd Arnold, University of Illinois, College of Medicine, "An Experimental Study of Host Susceptibility to Vibrio Cholerae Infections."

Dr. Ira Manville, University of Oregon, "Autoxidation as an Explanation of Some Hitherto Unexplained Results of Experimental Dietaries."

Dr. B. I. Philipps, University of Oregon, "Studies on the Hematology of Infants."

Dr. Warren Hunter and Dr. H. B. Myers, University of Oregon, "The Renal Function and Regeneration of Tubular Epithelium as Influenced by Capsulectomy in Mercurial Nephritis."

ENGINEERING:

Professor G. M. Braumé,
Professor T. F. Hickerson,
Professor Thorndike Saville,
} University of North Carolina.

GENERAL:

President Frank Parker Day, Union College, "The Relation between Science and Literature."

Dr. W. M. Davis, University of Arizona, "The Mental Qualities for Success in Research."

Professor F. K. Richtmyer, Cornell University, "The Science of Tweedledee and Tweedledum."

Professor E. C. Franklin, Stanford University, "Movie-ing around Africa."

Dr. I. F. Huddleson, Michigan State College, "Rambles through Tunis and Maltese Islands."

Professor Clarence M. Jackson, University of Minnesota, "What Is Science?"

President W. L. Poteat, Wake Forest College, "Relation of Research and Teaching."

Dr. H. A. McGuigan, University of Illinois, College of Medicine, "Impressions of Research Abroad."

Professor H. G. Deming, University of Nebraska, "Research Activities, Funds, Personnel of Some of the Great Corporations of This Country."

Professor R. V. Moore, University of Kansas, "The Grand Canyon of Colorado."

Dr. C. M. Yonge, Plymouth, England, "The Work of the Great Barrier Reef Expedition."

Dr. Harrison E. Howe, Washington, D. C., "Waste in Industry."

Professor Richard S. Lull, Yale University, "The World's Debt to Pure Science."

Professor William H. Weston, Harvard University, "Tropical Research and a Tropical Island."

# LIST OF MISSING PERSONS

## Can You Help Us Locate These Members?

| *Name* | *Chapter* | *Last Known Address* |
|---|---|---|
| Burdg, Clarence Foster | Neb. 1927 | 2147 "O" St., Lincoln, Neb. |
| Burg, F. A. | Missouri 1914 | 444 Ross Ave., Wilkinsburg, Pa. |
| Burgess, Arthur W. | Washington 1926 | |
| Burgess, Earle H. | Washington 1922 | |
| Burgess, Laurie Lorne | Ill. 1910 | E. I. DuPont Co., Wilmington, Del. |
| Burgum, Harry Pitkin | Iowa 1904 | 49 63rd St., Philadelphia, Pa. |
| Burke, Hugh Edmund | McGill 1923 | Royal Victoria Hospital, Pine Ave. W., Montreal, P. Q., Canada |
| Burke, Morgan Baxter | Case 1906 | c/o H. B. Prothern, Consulting Engr., Cleveland, Ohio |
| Burkey, Fred S. | Neb. 1923 | |
| Burkey, Joseph Raymond | Ohio 1908 | 761 W. Main St., Conneaut, Ohio |
| Burlage, Stanley Ross | Cornell 1922 | Dept. of Physiology, Cornell Univ., Ithaca, N. Y. |
| Burleigh, George Leslie | Neb. 1924 | 6400 North 24th St., Omaha, Neb. |
| Burnett, Samuel Howard | Cornell 1902 | 615 Bradley St., Laramie, Wyoming |
| Burnham, Martin Luther | Worcester 1925 | Willimantic, Conn. |
| Burns, Roy Wilbur | Purdue 1917 | 606 West 137th St., New York City |
| Burr, George Danforth | U. of Wash. 1925 | 6519 17th St., N. E., Seattle, Wash. |
| Burt, William H. | Kansas 1927<br>Calif. 1927 | Dept. of Zoology, Univ. of Calif., Berkeley, Calif. |
| Burton, William Ernest | Colo. 1913 | Operator, Colo. |
| Bushnell, Horace Leland | Ill. 1908 | 1910 L. C. Smith Bldg., Seattle, Wash. |
| Buskirk, Dr. William Henry | Mich. 1904 | 722 Pacific Mutual Bldg., Los Angeles, Calif. |
| Butler, Everette E. | Missouri 1915 | |
| Butler, Keith Huestis | McGill 1928 | |
| Butsch, J. Theodore | Ohio 1919 | |
| Butters, Roy Morrill | Colo. 1910 | 720 Convent St., Laredo, Texas |
| Buttner, Jacques Louis (Dr.) | Yale 1909 | c/o Mas de la Ville Co., Arles, France |
| Butts, Dr. John Harold | Iowa 1919 | Waterloo, Iowa |
| Byrd, Ralph Milledge | N. C. 1925 | Edgefield, S. C. |
| Byrns, Robert Winn | Ohio 1922 | 202 Burke Bldg., Seattle, Wash. |
| Cabin, Walter H. | Iowa 1913 | |
| Cahall, Roy Edgar | Chicago 1926 | Univ. of Chicago, Chicago, Ill. |

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| Cairnes, C. E. | U. of Wash. 1917 | Princeton Univ., Princeton, N. J. |
| Caldis, Panos D. | Calif. 1923 | Box 252, Univ. Farm, Davis, Calif. |
| Caldwell, Prof. George T. | Chicago 1912 | 4304 Eastside Ave., Dallas, Texas |
| Calhoun, Dr. Henrietta Anne | Mich. 1918 | Medical College, Iowa City, Ia. |
| Calland, Joseph Ward | Ohio 1913 | c/o Kilbourne Jacobs Mfg. Co., Columbus, Ohio |
| Calvert, William R. | Neb. 1911 | Utah Petroleum Co., Salt Lake City, Utah |
| Calvin, John W. | Neb. 1914 | |
| Cambron, Adrien | McGill 1923 | |
| Cameron, Charles Neal | Chicago 1920 | 524 Fourth St., Saskatoon, Saskatchewan, Canada |
| Cameron, Dr. Donald F. | Minn. 1917 | Fort Wayne, Ind. |
| Cameron, Hazel C. | Ohio 1912 | College of Medicines, Park St., Columbus, Ohio |
| Camp, Arthur Forrest | Calif. 1921<br>Washington 1922 | 4244 Shenandoah Ave., St. Louis, Mo. |
| Camp, Samuel Holcomb | Syracuse 1913 | Oakfield, N. Y. |
| Campbell, Alan Dichfield | Cornell 1923 | |
| Campbell, Albert A. | Minn. 1909 | Ogoma, Minn. |
| Campbell, Alexander | McGill 1924 | Engr. Bldg., McGill University, Montreal, P. Q., Canada |
| Campbell, C. Alfred | Ohio 1920 | Sales Ext. Div., Nordyke & Marmon Co., 919 Benn. St. N., Indianapolis, Ind. |
| Campbell, Clarence P. | Stanford 1914 | Stanford University, Calif. |
| Campbell, Eva Galbreath | Ohio 1919 | 124 E. Church St., Iowa City, Iowa |
| Campbell, Watson | Kansas 1912 | 825 Lathrop Bldg., Kansas City, Mo. |
| Canavarro, George de S. | Minn. 1908 | |
| Candee, Allan H. | Cornell 1906 | 1073 36th St., Milwaukee, Wis. |
| Canfield, Frederick A. | Columbia 1905 | Dover, N. J. |
| Canfield, Ora Lee | Purdue 1912 | R. R. 6, Royal Oak, Mich. |
| Capps, Earl Vanhise | Neb. 1899 | |
| Carder, Dean S. | Idaho 1925 | Potlatch, Idaho |
| Carey, Harley Frank | Brown 1920 | 19 2nd Ave., Newark, N. J. |
| Carghill, Miriam A. | Wis. 1925 | |
| Carlson, Clarence Selmer | Iowa 1928 | Beresford, S. D. |
| Carman, Gage Griffin | Ill. 1923 | Univ. of Ill., Urbana, Ill. |
| Carman, Simon | Rens. 1922 | c/o Sanderson & Porter, Cheat Haven, Pa. |
| Carney, Sidney Sylvester | Ill. 1922 | Univ. of Ill., Urbana, Ill. |
| Carpenter, Campbell Colon | Ind. 1906 | 941 South Ave., Niagara Falls, N. Y. |
| Carpenter, Charles Benjamin | Stanford 1923 | 554 E. Morrison St., Portland, Ore. |

## ANNOUNCEMENT FROM THE UNIVERSITY OF MINNESOTA

The contents of four lectures delivered under the auspices of Sigma Xi at the University of Minnesota form the symposium in biometrics entitled *The Measurement of Man* (University of Minnesota Press, $2.50), which was selected by the Scientific Book Club as its "book of the month" for August. The authors were the late Professor J. Arthur Harris, Professor Clarence M. Jackson, Professor Donald G. Paterson, and Professor Richard E. Scammon. Professor C. H. Bailey, president of the Minnesota Chapter of Sigma Xi, contributed the foreword for the book.

## CHAPTER OFFICERS

LIST FURNISHED BY THE SECRETARIES OF THE CHAPTERS

| CHAPTER | PRESIDENT | VICE-PRES. | SECRETARY | TREASURER |
|---|---|---|---|---|
| Cornell | F.O.Ellenwood | H. H. Love | W. A. Hagan | A. J. Heinicke |
| Rensselaer | E. R. Cary | F. W. Schwartz | F. M. Sebast | H. E. Stevens |
| Union | M. F. Sayre | F. W. Grover | C. B. Hurd | C. B. Hurd |
| Kansas | E. B. Stouffer | H. H. Lane | J.C.Stranathan | H. E. Jordan |
| Yale | J. S. Nicholas | R. H. Suttie | R. K. Warner | A. T. Waterman |
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